AD NUMBER
AD125304
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AUTHORITY
USNASC ltr, 16 Dec 1968; USNASC ltr, 16 Dec 1968

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NAVAL AIR TEST CENTER

Patuxent River, Maryland

Report....

PROJECT TED NO. PTR PP-5102.5

(U) PERFORMANCE EVALUATION OF THE J57-P-8A ENGINE IN THE F4D-1 AIRPLANE ON JP-5 FUEL, REPORT #1, FINAL REPORT

13 MAR 1957

SERVICE TEST DIVISION

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NAVAL AIR TEST CENTER
U. S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND

PTR PP-5102.5
ST312-09

CONFIDENTIAL

13 Feb 1957

PROJECT TED NO. PTR PP-5102.5; PERFORMANCE EVALUATION OF J57-P-8A ENGINE IN THE F4D-1 AIRPLANE ON JP-5 FUEL, REPORT #1, FINAL REPORT

ABSTRACT

1. This report covers an evaluation, conducted by the Service Test Division, of the J57-P-8A engine using JP-5 fuel. Two F4D-1 airplanes were utilized for the tests during which one airplane was flown a total of 123.5 hours and the other flown a total of 59.2 hours.

2. It is concluded that general engine operation was excellent. Inspection of the engines revealed no discrepancies which could be attributed to the use of JP-5 fuel. Engine performance is approximately the same as with JP-4 fuel.

3. It is recommended that JP-5 fuel be approved for use in the J57-P-8A engine installed in the F4D-1 airplane and that long reach igniter plugs be used to improve cold weather starting characteristics.

PTR PP-5102.5
ST312-09

NAVAL AIR TEST CENTER
U. S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND

CONFIDENTIAL

13 Feb 1957

From: Commander, Naval Air Test Center
To: Chief, Bureau of Aeronautics

Subj: Project TED No. PTR PP-5102.5; Performance Evaluation of the J57-P-8A Engine in the F4D-1 Airplane on JP-5 Fuel, Report #1, Final Report

Ref: (a) BuAer ltr Aer-PP-51/29 of 23 Mar 1956
(b) Test Number 4-2, BuAer Manual of Aircraft Test Directives
(c) F4D-1 Flight Handbook, AN 01-40FBA-1, of 1 Oct 1956

Encl: (1) Air Start Data Using Standard Igniter Plugs
(2) Air Start Data Using Long Reach Igniter Plugs
(3) Jam Acceleration Data

INTRODUCTION AND PURPOSE

1. Project TED No. PTR PP-5102.5 was established by reference (a), with a "B" priority, to conduct a flight evaluation of the J57-P-8A engine using standard grade JP-5 fuel.

DESCRIPTION OF EQUIPMENT

2. Two F4D-1 airplanes equipped with J57-P-8A engines were used for the tests. Engine serial P-604763 was installed in airplane BuNo 134746 and engine serial P-605098 was installed in BuNo 134803. The JP-5 fuel conformed to Mil Spec MIL-F-5624C.

RECORD OF TESTS

3. The following is a chronological record of the tests:

a. Date of project directive. . . . . 23 Mar 1956

b. Commenced JP-5 tests with engine serial P-604763 . . . . . 17 May 1956

c. Commenced JP-5 tests with engine serial P-605098 . . . . . 17 Jul 1956

d. Sixty hour inspection of engine serial P-604763 completed . . . . . 28 Aug 1956

e. Sixty hour inspection of engine serial P-605098 completed . . . . . 15 Nov 1956

f. One hundred twenty hour inspection of engine serial P-604763 completed . . . . . 28 Dec 1956

SCOPE AND METHOD OF TESTS

4. Tests were conducted in accordance with reference (b). Engine serial P-604763 was operated for 123.5 hours and engine serial P-605098 was operated for 59.2 hours under the following conditions:

FLIGHT TIME - HOURS

ENGINE	TOTAL	CRT	MRT	NRT
P-604763	123.5	13.9	23.9	26.2
P-605098	59.2	6.0	12.4	12.0

FLIGHT TIME AT ALTITUDE - HOURS

ENGINE	0-20,000'	20-30,000'	30-40,000'	40-50,000'	Above 50,000'
P-604763	41.8	21.7	29.4	29.8	0.8
P-605098	18.9	10.3	15.8	13.7	0.5

At approximately 60 hour intervals the engines were removed from the airplanes, disassembled and inspected.

RESULTS AND DISCUSSION

General

5. Minor fuel control adjustments were necessary when changing from 3:1 Jet Mix or JP-4 to JP-5. Approximately 0.5 man-hours were expended in "trimming" the engine by adjusting fuel

flow at the idle and MRT throttle positions. Engine performance was approximately the same with each fuel.

6. Inspection of the engines revealed no discrepancies which could be attributed to the use of JP-5 fuel. There was no evidence of corrosion or gumming. Inspection of the fuel systems revealed no evidence of deterioration of fuel cells or sealants.

Starting Characteristics

7. Ground starting characteristics were evaluated throughout the tests at ambient temperatures between 18°F and 90°F. Both standard igniter plugs (Champion AA 14-S) and long reach igniter plugs (Champion AA-10S and BG-C-11,000) were used. During cold weather starts with standard igniter plugs, light-offs were delayed and several starts were unsuccessful. All starts were normal with long reach igniter plugs. The following is an average of the times required for starting and static engine acceleration:

Ignite to light off . . . . . 5 seconds

Light-off to idle engine RPM. . . . .23 seconds

Idle to full engine RPM . . . . . 7 seconds

8. Successful air starts were made at altitudes from 5000 feet to 47,000 feet. The engine exhibited no tendencies to exceed temperature limits and acceleration from light-off to flight idle engine RPM was smooth. The air start procedures contained in reference (c) were evaluated and the high altitude/high engine RPM technique resulted in successful starts on almost every attempt. Consistent starts were not obtained above 25,000 feet when using an engine RPM range of from 12 to 30%.

9. Enclosure (1) is a tabulation of air start attempts with standard igniter plugs installed. Only three of nine attempts resulted in successful starts and these were obtained at relatively low altitudes. Enclosure (2) is a tabulation of air start attempts with long reach igniter plugs installed. When using the long reach igniter plugs, 34 of 50 attempts resulted in successful starts.

Jam Acceleration Characteristics

10. Enclosure (3) lists the average times required to accelerate the engine from idle to full RPM and from 80% to full RPM at altitudes of 2000, 5000, 15,000, 30,000 and 45,000 feet. The engine accelerated smoothly at altitudes below 30,000 feet. At altitudes above 30,000 feet jam accelerations resulted in light to moderate compressor stalls; acceleration through the 77-85% engine RPM range was slow although temperature limits were not exceeded.

Afterburner Performance

11. Afterburner blow-outs occurred at altitudes from 51,000 to 55,000 feet. Afterburner light-offs were obtained at altitudes up to 49,000 feet. Probability of light-off improved with increased air speed and the following table indicates the minimum air speed required to achieve consistent light-offs:

Altitude - Feet	Air Speed - KIAS
40,000	200
43,000	220
46,000	240

CONCLUSIONS

12. It is concluded that:

a. Minor fuel control adjustments were required when changing from 3:1 Jet Mix or JP-4 to JP-5. Engine performance was approximately the same with each fuel (Paragraph 5).

b. Inspection of the engine revealed no discrepancies which could be attributed to the use of JP-5 fuel (Paragraph 6).

c. Ground starting characteristics in cold weather were unsatisfactory with standard igniter plugs installed (Paragraph 7).

d. Ground starting characteristics were satisfactory with long reach igniter plugs installed in ambient temperatures as low as 18°F, the lowest encountered during the tests (Paragraph 7).

e. The air start procedures contained in reference (c) were satisfactory for use with JP-5 fuel (Paragraph 8).

f. The engine could be jam accelerated without flaming out or exceeding temperature limits (Paragraph 10).

g. Afterburner blow-out normally occurred at approximately 53,000 feet and consistent afterburner light-offs were obtained at 46,000 feet and 240 KIAS (Paragraph 11).

RECOMMENDATIONS

13. It is recommended that:

a. Long reach igniter plugs be utilized in the J57-P-8A engine to improve cold weather starting characteristics with JP-5 fuel.

b. JP-5 fuel be approved for use in the J57-P-8A engine installed in the F4D-1 airplane.

T. B. CLARK

DONALD GAY, JR.
By direction

F4D-1 AIR START DATA

(J57-P-8A ENGINE)

STANDARD IGNITER PLUGS (CHAMPION AA 14-S)

Altitude (Feet)	Airspeed (KIAS)	RPM (%)	Max EGT (°C)	Time to Light-Off (Seconds)	Successful (Yes or No)
25,000	210	28	-	-	No
25,000	210	27	-	-	No
20,000	200	26	-	-	No
20,000	200	25	-	-	No
19,000	200	25	300	28	Yes
15,000	190	25	-	-	No
15,000	190	24	-	-	No
10,000	190	23	300	25	Yes
7,000	170	20	300	25	Yes

F4D-1 AIR START DATA

(J57-P-8A ENGINE)

LONG REACH IGNITER PLUGS (CHAMPION AA 10-S and BG-C-11,000)

Altitude (Feet)	Airspeed (KIAS)	RPM (%)	Max EGT (°C)	Time to Light-Off (Seconds)	Successful (Yes or No)
47,000	220	70	450	4	Yes
45,000	230	72	450	4	Yes
43,000	250	66	350	4	Yes
43,000	250	64	-	-	No
42,000	250	52	350	4	Yes
40,000	250	68	400	8	Yes
40,000	240	60	-	-	No
40,000	220	40	350	5	Yes
40,000	200	35	-	-	No
38,000	220	52	300	4	Yes
37,000	210	50	300	5	Yes
35,000	270	68	400	4	Yes
35,000	260	70	400	3	Yes
35,000	230	35	-	-	No
35,000	220	33	-	-	No
35,000	170	30	-	-	No
33,000	200	40	300	4	Yes

Altitude (Feet)	Airspeed (KIAS)	RPM (%)	Max EGT (°C)	Time to Light-Off (Seconds)	Successful (Yes or No)
33,000	200	30	-	-	No
33,000	210	32	-	-	No
32,000	180	29	400	4	Yes
31,000	250	60	300	4	Yes
31,000	210	30	-	-	No
31,000	200	28	-	-	No
31,000	170	25	-	-	No
30,000	300	70	450	8	Yes
30,000	250	65	450	3	Yes
30,000	210	28	-	-	No
30,000	205	30	300	20	Yes
30,000	190	28	-	-	No
29,000	205	29	-	-	No
29,000	170	24	300	20	Yes
28,000	200	25	300	8	Yes
26,000	210	27	-	-	No
26,000	205	26	-	-	No
26,000	230	30	300	8	Yes
25,000	210	29	300	24	Yes
25,000	170	26	300	8	Yes

Altitude (Feet)	Airspeed (KIAS)	RPM (%)	Max EGT (°C)	Time to Light-off (Seconds)	Successful (Yes or No)
24,000	190	25	300	18	Yes
23,000	200	24	300	10	Yes
21,000	205	21	300	8	Yes
20,000	255	32	250	6	Yes
20,000	170	22	300	5	Yes
15,000	280	32	250	4	Yes
15,000	170	18	300	5	Yes
10,000	300	22	300	4	Yes
10,000	170	18	300	3	Yes
8,000	250	40	300	3	Yes
5,000	300	30	300	4	Yes
5,000	170	16	300	4	Yes

F4D-1 JAM ACCELERATION DATA
(J57-P-8A ENGINE)

ALTITUDE (Feet)	AIR SPEED (KIAS)	AVERAGE TIME IDLE TO FULL RPM (Seconds)	AVERAGE TIME 80% TO FULL RPM (Seconds)
45,000	220	40	32
30,000	220	27	18
15,000	220	10	6
5,000	220	7	4
2,000	135	8	4